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PHYTOTOXICOLOGY SURVEY IN THE VICINITY OF ALPINE PLANT FOOD

NEW HAMBURG, 1991

Report prepared by:

J. Craig Kinch

1.0 BACKGROUND AND INTRODUCTION

Alpine Plant Food Limited is a liquid fertilizer manufacturer located near the intersections of Arnold, Webster and Waterloo Streets, in New Hamburg. The property is leased by Alpine Plant Food from the Canadian National Railway. The main process involves the mixing of inorganic raw products to formulate a variety liquid fertilizers. The raw products include aqua-ammonia, urea, phosphoric acid, potash (KCl), ammonium phosphate and potassium hydroxide. Although no heat is used in the formulation process, the reactions may be mildly exothermic resulting in loss of volatiles, including ammonia (NH_3), to the vent.

Ambient concentrations of ammonia as a gas in the atmosphere range from approximately <3.5 to 70 ug/m^3 (Ref. 1). Average urban ammonia concentrations range from 20 to 140 ug/m^3 (Ref. 8; M.O.E., pers. comm.). Studies in agricultural fields fertilized with manure have found ground level ammonia concentrations exceeding 35 ug/m^3 (Ref. 3) while concentrations as high as 7000 ug/m^3 have been recorded in the vicinity of industrial facilities (Ref. 8). The M.O.E. Point of Impingement Standard (24 hour average based on odour) for ammonia is 3600 ug/m^3 (Ref. 5). The majority of human responses to ammonia odour are in the range of 4000 to 50000 ug/m^3, with some individuals being sensitive to much lower concentrations (Ref. 7).

Acute ammonia exposure to plants may result in a silvery glazed injury on the underside of the leaves, resembling the marks of other oxidants. The original foliar response to severe exposure is the appearance of a "cooked green" coloured foliage followed by foliar necrosis (browning) and death. On grass excess ammonia causes streaks on the leaf's edges and lesions between the veins (Ref. 4). Mustard plants and sunflower are amongst the most sensitive (Ref. 8) with rhubarb, poeny, gladiolus and catnip also being sensitive. While most coniferous tree species appear to be resistant to ammonia exposure, some deciduous species, including balsam poplar, mulberry, hawthorn, butternut and white birch are quite sensitive (Ref. 6).

Characteristic ammonia injury symptoms have been found on sunflower, buckwheat, coleus and tomato in the greenhouse as the result of 1 hour exposures to 28400 ug/m^3 (Ref. 4). Slight to marginal injury was also noted on these species, in the same study, with a 1 hour exposure to 11700 ug/m^3 gaseous ammonia. It is important to remember that these studies were not conducted on natural systems and that they do not speak to the impacts of chronic exposure to lower concentrations of ammonia.

There have been numerous ammonia odour problems associated with Alpine Plant Food dating back to the early 1970s. The majority of complaints have come from residents living on Arnold, Webster and Waterloo Streets because of their close proximity to the plant and because of the prevailing

wind directions. A New Hamburg citizen group (Neighbourhood Committee "Ammonia Alley", NCAA) was formed in the mid 1980s, and continues to be active, in pressing the local council and other agencies to examine the appropriateness of the plant operations and the company's compliance with local by-laws and environmental regulations.

NCAA was instrumental in having a letter drafted by council to the Cambridge District M.O.E. office to request their involvement and instruction. Ron McKnight of the Cambridge office visited the plant on May 16, 1990 and again on May 29, 1991. These visits resulted in the identification of a number of sources of ammonia odours. These sources included the truck wash area and truck wash waste water tank, improper venting of the aqua-ammonia storage tank and improper controls on stack gases originating from the exothermic reaction in the mixing tank and storage tanks containing warm finished product. As a result of these observations D. Ireland, (District Officer, Cambridge District) requested that the company engage a professional consulting firm to identify all sources of odour, to make recommendations for control of the odours and for the company to complete applications for Certificates of Approval (C of As) for control technologies.

In February, 1991, the Cambridge District office requested the assistance of the Phytotoxicology Section of the M.O.E. to identify patterns of soil and vegetation contamination in the vicinity of Alpine Plant Food.

2.0 SITE STUDIES AND METHODOLOGY

Meterological Data

Seasonal wind data for the general area were obtained from Environment Canada. The data were collected at the Ontario Agricultural College, Guelph, during the period from 1963 to 1980.

Vegetation and Soil Surveys

An initial visual survey of vegetation damage around the facility was conducted by the author and D.L. McLaughlin, on July 4, 1991. This survey involved close examination of vegetation on a number of properties in the vicinity of Alpine, with special emphasis on those areas known to have been exposed to ammonia odours in the past.

A grass and soil sampling survey was established in the summer of 1991, which included 18 sampling sites (see attached figure). These sites were selected to represent the area within close proximity to the plant with special emphasis on downwind locations and residential communities expressing ammonia odour problems. The sites were established in open and grassed areas known not to have been fertilized, with either organic or inorganic fertilizers, within the last 10 years.

Soil and grass collections were made on August 7-9, 1991 by the author. Duplicate soil samples (0-5 cm) were collected from an 100 m^2 area at each site. Each sample consisted of a minimum of 50 individual cores collected from random locations within the sample area. Samples were collected using a stainless steel core. Grass samples were also collected in duplicate and sampled from random locations within the same 100 m^2 area using sheers.

The grass samples were oven dried, ground in a Wiley-mill and stored in glass bottles. Soil samples were split into two sub-samples with the first sample being air dried, pulverized to pass through a 60 mesh sieve and also stored in glass bottles. The second, unprocessed sub-sample of soil was stored frozen and subsequently submitted for ammonia and nitrates analysis. The soil samples were then forwarded to the M.O.E. Laboratory Services Branch for analysis.

Raw Product Samples

Single composite samples of the following raw products, used in the Alpine Plant Food process, were provided by the company for chemical analysis:

White Phosphoric Acid	*Potassium Chloride Potash*
High Quality Phosphoric Acid	*Potassium Hydroxide*
Ammonium Phosphate	*Aqua Ammonia*

3.0 RESULTS AND DISCUSSION

Wind Patterns

Table 1 summarizes seasonal wind data collected by Environment Canada at the Ontario Agricultural College, in Guelph, during the period from 1963 to 1980 (Ref.2):

Table 1: Wind Direction Frequencies for the Ontario Agricultural College, Guelph, Ontario (1963-1980) (Ref. 2)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Percentage Frequency													
N	7.8	10.6	10.9	12.6	9.8	9.1	10.8	10.5	7.8	6.6	8.1	9.5	9.5
NE	6.8	7.4	8.9	8.8	8.2	6.1	5.8	6.0	7.7	4.4	5.7	7.4	6.9
E	11.1	8.3	16.4	19.5	16.9	12.5	9.0	8.7	15.8	10.6	10.9	11.9	12.6
SE	3.2	2.3	3.3	7.2	5.3	6.7	5.3	4.5	7.4	6.0	5.9	4.4	5.1
S	6.9	8.3	6.5	7.8	8.5	11.5	12.7	10.2	11.0	15.1	12.9	9.3	10.1
SW	23.1	16.4	12.7	11.7	13.9	17.3	17.1	16.5	15.3	19.9	17.4	17.9	16.6
W	28.7	29.2	25.9	19.4	22.0	22.4	22.7	24.2	19.6	25.1	27.6	27.5	24.5
NW	11.5	17.1	15.1	12.4	14.8	13.0	15.1	17.4	14.0	10.9	10.7	10.8	13.6
CALM	0.9	0.4	0.3	0.6	0.6	1.4	1.5	2.0	1.4	1.4	0.8	1.3	1.1

These data emphasize the strong tendency toward westerly, southwesterly, and northwesterly winds during the growing season. Winds from the east, possibly associated with weather disturbances, were also strongly represented.

Visual Survey of Vegetation Damage

At the time of the visual survey, there were no signs of ammonia-like injury on any of the plant species examined. The survey included examination of a number of sensitive species in close proximity to the facility and in residential areas that have complained of offensive ammonia odours.

Soil and Vegetation Chemistry

It was anticipated that it would be difficult to demonstrate a pattern of nitrogen "contamination" in soils and vegetation around Alpine, even if the facility were a major source of ammonia, because of the magnitude of natural nitrogen compounds in soil and vegetation. Therefore, soil and vegetation samples were analyzed for a number of inorganic elements and radionuclides, in addition to total nitrogen, which may have been associated with Alpine emissions. These inorganic "tracers" may be impurities in the raw products used in the reactions. For example, phosphoric acid originating from the west coast of North America may have a variety of impurities, including cadmium, fluoride, lead, arsenic and vanadium (Van Straaten, University of Guelph, pers. comm.). Phosphoric acid originating from Florida may contain uranium, fluoride, radium and radon. Potash may also contain quantities of sodium. Ammonia and nitrate analyses were also conducted on soils because of the ability of soil bacteria to convert ammonia to nitrites and nitrates. However, this process of nitrification may occur

quite quickly. In a study on agricultural fields, it has been shown that at a rate of application of ammonia of 100 kg/ha the majority of ammonia is converted to other forms of nitrogen in 7 days (Beauchamps, University of Guelph, pers. comm.).

The analytical results for grass and soils are presented in Tables 2 to 5. Where available, the Phytotoxicology ULN guidelines (see appendix) are also listed in these tables.

The ULN guidelines for rural areas are generally lower than for urban areas. While these guidelines are not necessarily applicable in this case, they do provide a more conservative database with which to assess potential impacts from the plant. Also there are no urban ULNs for grass. The rural ULNs were exceeded at one or more stations for Cu, Pb, Zn, Fe and Cl in grass (Table 2). However, except for copper, zinc and chloride, all of the exceedences occurred in grass collected from Site 11, which is located 500 m upwind of the facility. Site 11 is located on the south side of Shade Street (15 m from the road) east of a bridge crossing the Nith River on the property of a municipal sewage lift station. The rural ULN for copper in grass was exceeded at 11 of the 18 sampling sites. However, grass collected from stations downwind and nearest the site were not consistently elevated in copper compared with more distant and upwind stations; contrary to the expected pattern if Alpine were a Cu source. In fact, 4 of the 10 stations exceeding the rural ULN for Cu were located 1000 or more meters from the facility and the three sites closest and most directly downwind had the lowest grass copper concentrations. Similarly, exceedences for Zn and Cl at Sites 10 and 7, respectively, did not appear to be related to emissions from Alpine. In addition, there were no apparent nitrogen or phosphorus gradients in grass around the plant.

There were, similarly, few exceedences of the rural ULNs for soil collected around the plant (Table 3). However, elevated copper concentrations were detected in surface soils collected from the two sites closest to the facility (Sites 1 and 10). The arsenic concentration in soil at Site 1 was also above the rural ULN. In contrast, the highest phosphorus and total nitrogen concentrations occurred at sites distant from the facility. With the exception of copper at Site 10, there were no elements for which the rural ULNs were exceeded for both soil and grass.

The results of ammonia and nitrate analysis in soils are presented in Table 4. The data suggest that concentrations of ammonia in soils collected northeast of the plant may be marginally higher than those collected elsewhere in the survey, although a clear ammonia gradient in soil downwind of the facility was not evident. For example, the concentration of ammonia in soils collected 100 m from Alpine (Site 2) was similar to that collected 2000 m from the facility (Site 6). Similarly, while the ammonia:nitrate ratio fell fairly consistently from Site 1 to Site 6 (6.4 to 4.9), the highest ammonia:nitrate ratio occurred at Sites 14 and 17 (7.6 and 7.2, located 800 m SSE and 1000 m E, respectively). The lack of a clear ammonia or nitrogen gradient with distance from the facility is not surprising, as noted earlier, due to the rapid nitrification of ammonia and the high absolute

concentrations of nitrogen compounds in soils.

The concentrations of radioactive compounds in soils are presented in Table 5. The data do not indicate a radionuclide deposition pattern around Alpine. Therefore, radioactive impurities in the raw products are not being emitted from the facility in concentrations likely to have a significant impact on the terrestrial environment.

A number of observations suggest that Alpine Plant Food is not having a significant impact on local soils and vegetation:

1) There were no visual signs of air pollution-related vegetation damage in the vicinity of the plant nor were there any signs of ammonia-like injury on sensitive vegetation species.

2) In general, concentrations of inorganic elements in soil and grass around the facility were considered in the normal range for a rural area (rural ULNs).

3) There were no consistent concentration gradients for any of the elements relative to distance and direction from Alpine.

4) Except in the case of copper at one upwind site, there were no individual elements for which concentrations in soil and vegetation were concurrently and consistently elevated.

The concentrations of inorganic and radionuclide impurities contained in raw products used in the plant are summarized in Table 6. The results indicate that a number of the products, especially phosphoric acids and ammonium phosphate, contain non-trace concentrations of a variety of impurities. Copper and arsenic, two elements found to be above the rural ULN in soils closest to the plant, were present in the high quality phosphoric acid and ammonium phosphate. However, the following observations suggest that the presence of these elements in the raw products is not sufficient to explain the marginally elevated soil concentrations around the facility:

1) The concentrations of Cu and As in the raw products were elevated but not excessive, especially relative to concentrations of Zn, Fe, Mn, Cr, V and U-238.

2) If impurities were released from phosphoric acid and ammonium phosphate during the process in large enough quantities to result in elevated arsenic and copper concentrations, then there should be elevated concentrations of other impurities in local soil and vegetation. However, this did not occur.

This leaves the following observations unexplained:

1) Elevated concentrations of copper and other heavy metals in grass collected from Site 11 (500 m SW).

2) Elevated concentration of copper in soil at Site 10 (100 n SW).

Further work would be required to establish the cause of these elevated heavy metal concentrations. However, a possible source of heavy metals in the area is the Riverside Brass Foundry. Riverside Brass is located approximately 1 block southwest of Alpine.

4.0 SUMMARY

Although ammonia odours have been associated with the plant and may continue to date, the data generally indicate that concentrations of elements in soil and vegetation around Alpine Plant Food were within the range considered normal for a rural area. In addition, there was no contamination gradient in samples near and/or downwind of the facility. The data suggested that concentrations of inorganic elements in Alpine's emissions were not sufficient to result in measurable downwind terrestrial contamination. Further work will be required to determine the cause of elevated heavy metal concentrations in soil and vegetation in the area, which could not be attributed to Alpine.

5.0 REFERENCES

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Sketch Map of Soil and Grass Sampling Sites in the Vicinity of Alpine Plant Food, New Hamburg, 1991.

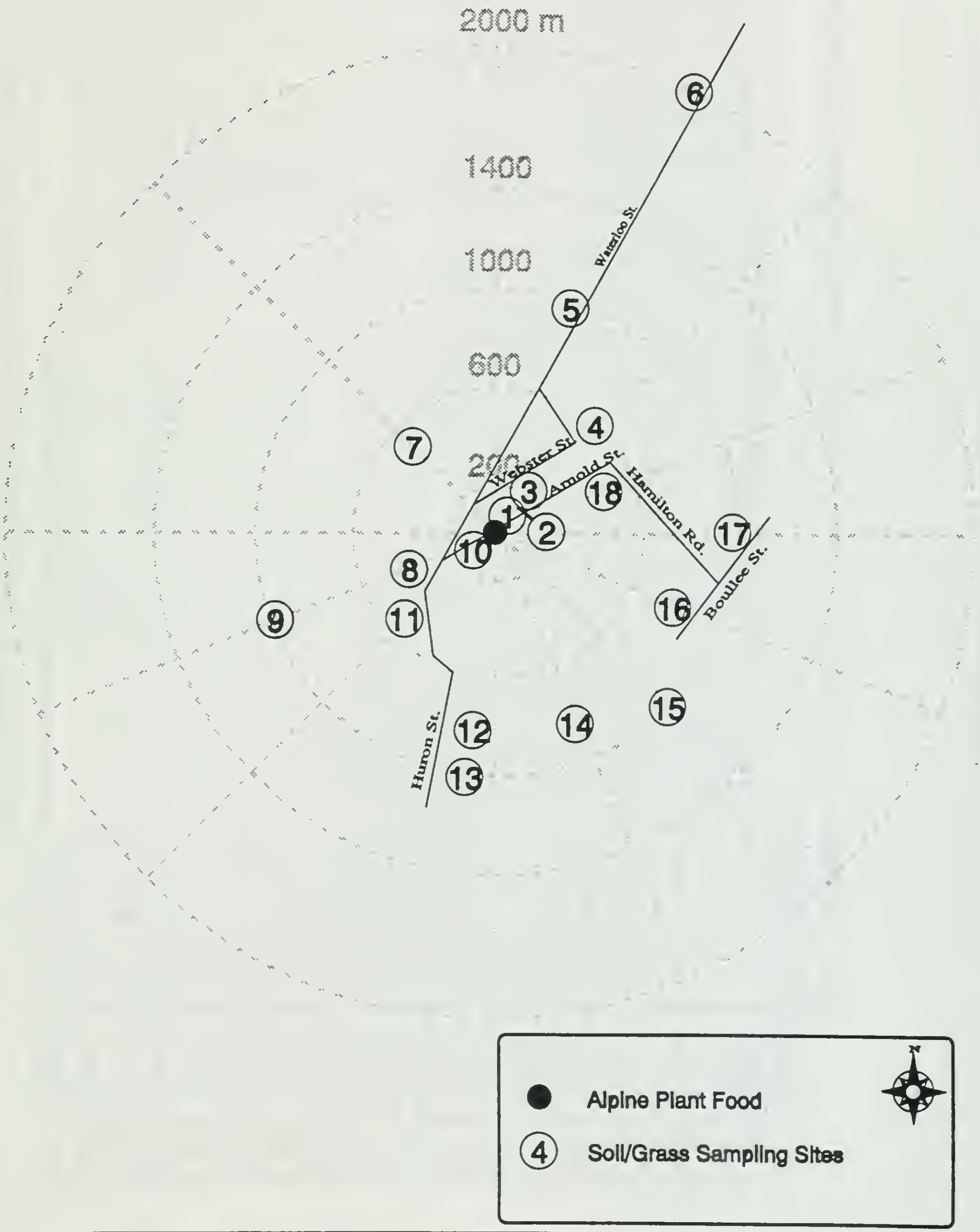

Table 2: Concentrations of Inorganic Elements in Grass Samples Collected in the Vicinity of Alpine Plant Food, New Hamburg, 1991.

Site	Direction/ Distance (m)	Concentrations of Inorganic Elements in Grass (ug/g unless otherwise indicated)																				
		U	Cu	Ni	Pb	Zn	Fe	Mn	P	N	Al	As	Cd	Cl	Co	Cr	F	K	Mo	Na	Sr	S	V
									mg/g					%				%				%	
1	NE 50	DL	6.4	DL	DL	18	49	23	3.7	21	16<T	DL	DL	0.41	DL	DL	2.3<T	2.6	1.1	12	15	0.24	DL
2	NE 100	DL	6.0	0.7<T	0.6<T	22	46	26	5.1	22	11<T	DL	DL	0.74	DL	DL	1.3<T	2.9	1.6	17	8.5	0.35	DL
3	NE 200	DL	5.5	1.1<T	DL	24	46	18	4.2	23	10<T	DL	DL	0.94	DL	DL	0.7<T	2.6	1.5	7<T	7.7	0.25	DL
4	NE 500	DL	**9.3**	2.1<T	1.5<T	32	290	44	5.1	37	230	DL	DL	0.67	0.3<T	DL	1.6<T	2.7	2.7	38	13	0.29	DL
5	NE 1000	DL	3.9	1.6<T	0.7<T	20	130	32	4.1	21	84	DL	DL	0.58	DL	DL	0.9<T	2.0	0.6<T	26	11	0.31	DL
6	NE 2000	DL	**8.2**	1.7<T	1.3<T	28	66	36	5.4	41	7<T	DL	DL	0.98	DL	DL	0.6<T	2.6	1.0<T	22	13	0.31	DL
7	NW 500	DL	**9.6**	1.8<T	DL	32	160	29	5.0	37	110	DL	DL	**1.1**	DL	DL	1.0<T	2.8	1.8	65	13	0.36	DL
8	WSW 400	DL	**8.4**	1.5<T	1.2<T	30	220	42	6.3	29	160	DL	DL	0.71	0.2<T	DL	1.2<T	2.3	1.1	36	15	0.25	DL
9	WSW 1000	DL	6.1	1.6<T	1.4<T	28	150	38	5.4	28	94	DL	DL	0.97	DL	DL	1.0<T	2.0	1.2	37	52	0.27	DL
10	SW 100	DL	**12**	2.0<T	2.0	**59**	320	35	4.0	27	190	DL	DL	0.89	0.3<T	0.7<T	2.6	2.1	1.9	56	14	0.22	DL
11	SW 500	DL	**16**	4.1	**28**	**130**	**540**	40	5.4	26	160	0.3<T	DL	0.89	1.8	0.5<T	1.0<T	2.3	2.0	89	17	0.33	DL
12	S 800	DL	**7.8**	1.6<T	DL	27	70	33	4.2	38	8<T	DL	DL	0.91	0.3<T	DL	0.9<T	2.5	1.3	14	12	0.31	DL
13	S 1000	DL	**11**	1.8<T	DL	38	160	41	4.5	42	180	DL	DL	0.87	0.4<T	DL	1.8<T	2.8	1.4	81	12	0.30	DL
14	SSE 800	DL	6.8	1.4<T	DL	33	85	21	4.0	33	24	DL	DL	0.63	0.2<T	DL	1.7<T	2.2	1.2	45	13	0.27	DL
15	SE 1000	DL	**8.7**	1.3<T	0.8<T	33	140	41	3.0	30	86	DL	DL	0.62	DL	DL	1.0<T	1.0	1.8	61	12	0.37	DL
16	ESE 800	DL	5.5	1.3<T	DL	21	140	36	4.3	31	79	DL	DL	0.85	DL	DL	1.6<T	2.0	1.4	19	12	0.23	DL
17	E 1000	DL	**8.7**	1.8<T	1.1<T	35	190	43	3.6	28	100	DL	DL	0.87	0.3<T	DL	1.4<T	2.2	1.8	265	16	0.29	DL
18	ENE 500	DL	**7.3**	1.5<T	DL	32	110	24	4.0	28	60	DL	DL	0.62	0.3<T	DL	DL	2.1	2.4	175	13	0.36	DL
ULN Guideline (grass)		NA	7	5	20	40	500	NA	NA	NA	NA	NA	0.5	1	2	5	12	NA	6	NA	NA	0.50	6

Notes: Values represent the mean of two replicate samples.
Values in bold and underlined exceed M.O.E. Upper Limit of Normal (ULN) Guideline for grass collected in rural areas of southern Ontario.

Table 3 :Concentrations of Inorganic Elements in Soil Samples Collected in the Vicinity of Alpine Plant Food, New Hamburg, 1991.

Site	Direction/ Distance (m)	Concentrations of Inorganic Elements in Soil (0-5) (ug/g unless otherwise indicated)																						
		U	Cu	Ni	Pb	Zn	Fe	Mn	P	N	Al	As	Ca	Cd	Co	Cr	P	K	Mg	Mo	Na	Sr	S	V
									mg/g														%	
1	NE 50	0.7	**<u>72</u>**	23	32	110	23000	540	1.10	3.8	20000	**<u>11</u>**	7600	0.54	8.7	28	70	3500	5700	DL	94	22	0.05	41
2	NE 100	0.6	49	25	30	110	26000	690	1.10	3.8	21000	8.5	11000	0.75	11.0	30	67	3700	7200	DL	90	26	0.05	45
3	NE 200	0.6	39	21	22	87	21000	500	1.10	3.9	18000	5.9	20000	0.88	7.6	25	79	2800	7300	DL	100	36	0.05	38
4	NE 500	0.3	14	13	15	61	15000	450	0.89	3.7	12000	2.6	11000	0.60	4.8	18	81	1900	4900	DL	120	20	0.04	32
5	NE 1000	0.7	25	21	19	75	23000	**<u>800</u>**	0.94	3.2	18000	4.0	5100	0.85	9.2	27	67	3200	4800	DL	82	17	0.03	41
6	NE 2000	0.4	18	15	21	67	16000	540	0.82	3.5	13000	3.5	17000	0.80	5.6	21	83	2200	7000	DL	110	24	0.05	32
7	NW 500	0.6	28	19	15	76	20000	550	1.1	4.4	18000	4.1	8900	1.9	7.8	25	70	3100	5400	DL	91	22	0.05	37
8	WSW 400	0.5	19	17	12	74	18000	580	1.0	2.0	15000	3.2	17000	0.82	5.5	20	110	2000	7000	DL	110	26	0.02	35
9	WSW 1000	0.5	18	17	20	68	18000	600	1.1	3.2	16000	3.9	13000	0.73	6.3	23	73	2200	5300	DL	95	47	0.04	34
10	SW 100	0.5	**<u>106</u>**	24	105	220	12000	380	0.96	3.0	7500	2.4	72000	0.82	4.1	19	110	1600	**<u>29000</u>**	DL	160	63	0.05	26
11	SW 500	0.5	39	18	46	160	17000	470	0.79	2.3	14000	3.6	51000	0.79	6.4	21	120	2700	**<u>13000</u>**	DL	150	65	0.04	33
12	S 800	0.4	47	23	20	75	23000	700	1.1	4.0	20000	4.3	9500	0.68	9.6	27	90	4100	5800	DL	100	23	0.06	41
13	S 1000	0.4	30	20	33	77	18000	460	0.95	2.5	15000	4.8	33000	0.35	6.8	23	99	3100	9700	DL	130	48	0.04	35
14	SSE 800	0.3	15	10	30	79	16000	350	0.93	2.1	9700	3.1	17000	0.54	3.9	18	76	1200	7400	DL	99	23	0.03	34
15	SE 1000	0.4	26	13	14	65	17000	620	0.96	2.9	13000	4.7	9300	0.27	3.8	22	95	2000	5900	DL	140	19	0.04	35
16	ESE 800	0.8	46	24	17	83	25000	690	1.6	4.0	22000	5.3	22000	0.61	11.0	33	130	4600	9000	DL	120	39	0.05	47
17	E 1000	0.5	34	25	13	71	22000	560	0.88	3.4	21000	4.6	25000	0.82	9.3	28	100	3900	9300	DL	130	41	0.03	41
18	ENE 500	0.4	32	20	18	110	21000	550	0.79	2.9	19000	4.6	7300	0.62	8.1	25	58	2800	5100	DL	93	21	0.05	39
ULN Guideline (Soil)		NA	60	60	150	500	35000	700	NA	NA	NA	10	NA	3	25	50	NA	NA	10000	2	NA	NA	0.1	70

Notes: Values represent the mean of two replicate samples.
Values in bold and underlined exceed M.O.E. Upper Limit of Normal (ULN) Guideline for soil (0-5 cm) collected in rural areas of southern Ontario.

Table 4: Concentrations of Nitrogen Compounds in Soil Samples (0-5 cm) Collected in the Vicinity of Alpine Plant Food, New Hamburg, 1991.

Site	Direction/ Distance (m)	Concentrations of Nitrogen Compounds (mg/L as Nitrogen)	
		Ammonium	Nitrates
1	NE 50	59.7	9.34
2	NE 100	47.1	7.7
3	NE 200	59.6	13.2
4	NE 500	54.6	10.7
5	NE 1000	26.3	4.6
6	NE 2000	46.6	9.5
7	NW 500	49.7	10.5
8	WSW 400	27.4	7.5
9	WSW 1000	22.8	6.5
10	SW 100	29.8	6.5
11	SW 500	25.1	5.1
12	S 800	35.9	13.1
13	S 1000	27.2	6.7
14	SSE 800	46.3	6.1
15	SE 1000	39.7	9.6
16	ESE 800	28.2	11.6
17	E 1000	26.8	3.7
18	ENE 500	25.9	5.9

Note: Values represent the mean of two replicate samples.

Table 5: Concentrations of Radioactive Compounds in Soil Samples Collected in the Vicinity of Alpine Plant Food, New Hamburg, 1991.

Site	Direction/ Distance (m)	Concentrations of Radioactive Compounds in Soils (0-5 cm) (Bq/g dry weight basis)		
		U-238	K-40	Ra-226
1	NE 50	<0.05	0.81	<0.05
2	NE 100	<0.05	0.86	<0.05
3	NE 200	<0.05	0.66	<0.05
4	NE 500	<0.05	0.70	<0.05
5	NE 1000	<0.05	0.80	<0.05
6	NE 2000	<0.05	0.64	<0.05
7	NW 500	<0.05	0.87	<0.05
8	WSW 400	<0.05	0.75	<0.05
9	WSW 1000	<0.05	0.74	<0.05
10	SW 100	<0.05	0.52	<0.05
11	SW 500	<0.05	0.68	<0.05
12	S 800	<0.05	0.85	<0.05
13	S 1000	<0.05	0.72	<0.05
14	SSE 800	<0.05	0.77	<0.05
15	SE 1000	<0.05	0.65	<0.05
16	ESE 800	<0.05	0.79	<0.05
17	E 1000	<0.05	0.79	<0.05
18	ENE 500	<0.05	0.73	<0.05

Note: Values represent analysis of a single composite sample for each site performed by gamma spectrometry on 25g of sealed and dried sample.

Table 6: Concentrations of Inorganic Elements (mg/L) and Radionuclides (Bq/L) in Raw Products Used in the Alpine Plant Food Process, 1991.

Element Conc. (mg/L)	White Phosphoric Acid	H.Q. Phosphoric Acid	Ammonium Phosphate	Potassium Hydroxide	Aqua Ammonia	KCl Potash
U	<0.04	<0.04	45	<0.04	<0.02	<1.0
Cu	0.22	17	7	0.07	0.06	DL
Ni	1.5	15	10	0.23	0.02<T	DL
Pb	2.3	3.8	2.1	1.8	0.02<T	DL
Zn	1.5	160	81	0.19	0.02<T	DL
Fe	7.8	1900	1000	3.5	0.13	DL
Mn	0.87	300	150	0.09	0.003<T	DL
P	NA	NA	NA	NA	NA	NA
Al	3.5	870	310	190	0.24	DL
As	0.47	10.3	10.3	DL	DL	DL
Ba	0.11<T	0.38	0.28	0.67	0.007<T	DL
Be	0.004<T	1.2	0.71	0.002	DL	DL
Ca	0.23	14	9.4	0.07	DL	DL
Co	0.31<T	1.3	0.84	0.1	DL	DL
Cr	12	230	100	0.11	0.009<T	DL
K	NA	NA	NA	DL	5.7	DL
Mo	1.3	5.5	2.5	0.24	DL	DL
Sr	0.032<T	0.02<T	0.06	0.35	0.001<T	DL
S	DL	DL	DL	NA	DL	DL
Ti	0.86	77	33	1.6	0.008<T	DL
V	0.34<T	130	61	0.11	DL	DL
Radionuclide Conc. (Bq/L)						
U-235	DL	120	65	DL	DL	DL
U-238	DL	2300	1000	DL	DL	DL
K-40	DL	DL	DL	17000	830	19
Ra-226	0.15	0.17	0.71	0.22	<0.10	<0.10

Notes: Values represent the analysis of single samples supplied by Alpine Plant Food.
NA - not analysed
DL - no measurable response in the diluted sample
<T - a measurable trace amount after dillution of sample

6.0 APPENDIX

Derivation and Significance of the MOE Phytotoxicology "Upper Limits of Normal" Contaminant Guidelines.

The MOE Upper Limits of Normal (ULN) contaminant guidelines represent the expected maximum concentration in surface soil, foliage (trees and shrubs), grass, moss bags, and snow from areas in Ontario not exposed to the influence of a point source of pollution. Urban ULN guidelines are based on samples collected from developed urban centres, whereas rural ULN guidelines were developed from non-urbanized areas. Samples were collected by Phytotoxicology staff using standard sampling procedures (ref: Ontario Ministry of the Environment 1983, Phytotoxicology Field Investigation Manual). Chemical analyses were conducted by the MOE Laboratory Services Branch.

The ULN is the arithmetic mean, plus three standard deviations of the mean, of the suitable background data. This represents 99% of the sample population. This means that for every 100 samples which have not been exposed to a point source of pollution, 99 will fall within the ULN.

The ULNs do not represent maximum desirable or allowable limits. Rather, they are an indication that concentrations that exceed the ULN may be the result of contamination from a pollution source. Concentrations that exceed the ULNs are not necessarily toxic to plants, animals, or people. Concentrations that are below the ULNs are not known to be toxic.

ULNs are not available for all elements. This is because some elements have a very large range in the natural environment and the ULN, calculated as the mean plus three standard deviations, would be unrealistically high. Also, for some elements, insufficient background data is available to confidently calculate ULNs. The MOE Phytotoxicology ULNs are constantly being reviewed as the background environmental data base is expanded. This will result in more ULNs being established and may amend existing ULNs.